

Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project

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**Idaho
Completion
Project**

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ABSTRACT

The Waste Area Group 7 Operable Unit 7-13/14 Probing Project captures field, electronic, and analytical data generated to support the Operable Unit 7-13/14 remedial investigation/feasibility study and a record of decision. The types of data included in this activity include data generated from analytical samples (both lysimeter [liquid] and soil vapor probe [gas]), nuclear logging activities, real-time in situ monitoring devices (tensiometers and soil moisture probes), and visual images of waste zones (borehole video and optical televiewer) within Operable Unit 7-13/14. This report documents and summarizes the data generated and collected in the Operable Unit 7-13/14 Probing Project during Fiscal Year 2003. This report also appends these data to the data from Fiscal Year 2002, supporting the remedial investigation/feasibility study process and a record of decision for Operable Unit 7-13/14.

Samples were collected from eight of the eighteen Type B vapor probes during Fiscal Year 2003. During the last quarter, samples were obtained from an additional five probes that had previously not yielded a sample because of plugging or other difficulty. Some discrepancies are being investigated between the photoacoustic portable multigas analyzer and on-Site laboratory analysis. The volatile organic compound concentrations are steady or decreasing slightly, depending on the location. The results also support information and assumptions used to estimate the original amount of volatile organic compounds buried in the Subsurface Disposal Area as well as burial locations of the volatile organic compound waste. Volatile organic compound concentrations from the probes are comparable to those predicted to be in equilibrium with Series 743 sludge. Some volatile organic compound concentrations appear to be seasonally dependent. This is plausible given the volatilization and partitioning dependence on temperature. The C-14-specific activity is substantially elevated (on the order of 100 times) above the naturally occurring levels at SVR-12 and originates from activated carbon steel.

One waste-zone lysimeter at Probe 741-08-L1 yielded approximately 10 mL of water during Fiscal Year 2003. The sample was analyzed for gamma-emitting radionuclides with no positive detections. There was inadequate volume to perform other radiological analyses.

Continuous water potential data from four tensiometer locations in the Subsurface Disposal Area indicate that infiltration occurs through surficial sediment and through waste despite less-than-average precipitation in the last 2 years. The lack of working tensiometers over a depth profile prevents use of water potential data for hydraulic gradients or estimates of infiltration rates. It is recommended that the tensiometers be monitored through fall 2004 to provide needed corroboration of soil moisture data in a year that should provide greater potential for infiltration through snowmelt. If the functionality of tensiometers does not improve, it also is recommended that consideration be given to halting the collection of tensiometer data at the end of Fiscal Year 2004.

The soil moisture probes have received considerable attention this past year to correct problems and bring as many probes online as possible. The soil moisture probes were individually interrogated to collect readings and determine

functionality. All dataloggers have been reprogrammed with calibrations for probes that had corrupt calibrations. Soil moisture probe communication wiring was reconfigured so that each probe is on an individual RS-485 driver. This work resulted in successfully bringing several clusters of soil moisture probes online. The recommendations are to collect raw and processed data from representative probes for one quarter and reevaluate the soil moisture probes at that time, to develop and apply a temperature correction to the soil moisture probe measurements, and to perform controlled experiments to determine impact of soil resistivity and salinity on moisture measurements.

The visual probes were logged for a second time with the optical televiewer during Fiscal Year 2003, and no change in subsurface conditions could be identified. The images are available for inspection on CD in the Operable Unit 7-13/14 Project files as required. The visual probe and optical televiewer have proven to be useful tools for visual examination of subsurface conditions, but no further utilization of the visual probes is anticipated at this time.

Thirty-seven Type A probes were installed in the Subsurface Disposal Area and were logged with a suite of nuclear logging tools including spectral gamma, neutron moisture, passive neutron, neutron capture, and azimuthal. The combined use of WasteOScope inventory data and surface geophysics was generally successful for locating subsurface contamination within the Subsurface Disposal Area. In most cases, the contamination was consistent with the expected waste inventory. Very high cesium-cobalt levels were observed in the west end of Trench 24. Europium-154 was identified as a common constituent in many of the new study areas. Measurement of azimuthal data at 6-in. depth intervals in two probes showed that both apparent concentration and position of radionuclide sources change continually with depth, supporting the conclusion that radionuclide contamination in the Subsurface Disposal Area is highly heterogeneous. High-sensitivity measurements within underburden soil in two probes showed that downward vertical migration of radionuclides is very limited.

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ACRONYMS

ARA	Applied Research Associates, Inc.
DU	depleted uranium
ECL	Environmental Chemistry Laboratory
FY	fiscal year
GC/MS	gas chromatography/mass spectrometry
INEEL	Idaho National Engineering and Environmental Laboratory
OU	operable unit
PCE	tetrachloroethene
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SMR	soil moisture, resistivity, and temperature
SWLO	Southwest Laboratory of Oklahoma
TCA	1,1,1-trichloroethane
TCE	trichloroethene
VOC	volatile organic compound

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1. INTRODUCTION

1.1 Purpose

The field, electronic, and analytical data generated for the Waste Area Group 7 Operable Unit (OU) 7-13/14 Probing Project during Fiscal Year (FY) 2003 are summarized in this report. The types of data addressed in this report include data generated from the analysis of lysimeter samples (liquid) and soil vapor probe samples (gas); data from nuclear logging activities, real-time in situ monitoring using tensiometers, and soil moisture probes; and data from visual probe images of waste zones (optical televiewer) within OU 7-13/14. The OU 7-13/14 Probing Project is being conducted in the Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL) to support the OU 7-13/14 remedial investigation/feasibility study, leading to a record of decision. The designation for the RWMC is Waste Area Group 7, recognized under the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991) and the “Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund)” (42 USC § 9601 et seq., 1980).

1.2 Scope

Documentation for the OU 7-13/14 Probing Project includes the *Operable Unit 7-13/14 Plan for the Installation, Logging, and Monitoring of Probeholes in the Subsurface Disposal Area* (INEEL 2000), hereinafter referred to as the *Probehole Plan*; *Field Sampling Plan for Monitoring Type B Probes for the Operable Unit 7-13/14 Integrated Probing Project* (Salomon 2003), hereinafter referred to as the *Field Sampling Plan*; and *Data Management Plan for the Operable Unit 7-13/14 Integrated Probing Project* (Salomon 2002), hereinafter as the *Data Management Plan*. The *Probehole Plan* (INEEL 2000) is the initial planning document for the OU 7-13/14 Probing Project and is a plan for two phases of probing. The first phase is the installation of Type A probes that are installed in selected focus areas in the SDA and that provide access to the subsurface for nuclear logging. The data from logging of the Type A probes provide information for the selection of locations for Type B probes to be installed as the second phase of the probing project. The *Field Sampling Plan* (Salomon 2003) describes how and where Type B probes will be installed, how samples will be collected from the Type B probes, and how the Type B probes will be monitored. The *Data Management Plan* (Salomon 2002) describes the process for the capture and maintenance of all field, electronic, and analytical data generated in the OU 7-13/14 Probing Project. The OU 7-13/14 probing activities conducted through the end of FY 2002 are summarized in the *Fiscal Year 2002 Summary Report for the OU 7-13/14 Probing Project* (Myers et al. 2003), hereinafter referred to as the *FY 2002 Summary Report*. The data within the scope of this summary report were derived from probes installed in the SDA, which are Type A Probes (nuclear logging) and Type B probes (soil vapor probes, lysimeters, tensiometers, soil moisture probes, and visual probes) collected during FY 2003.

1.3 Background

The OU 7-13/14 Probing Project has been involved in the designing, constructing, installing, and monitoring of Type A and Type B probes in the SDA. This work is conducted to support the OU 7-13/14 remedial investigation/feasibility study process and to reach a record of decision. Monitoring within the waste zone is a unique application of these technologies at the INEEL. All previous monitoring at the

SDA has been between waste disposal locations or at depth in sedimentary interbeds. Table 1-1 contains additional detail on the types of probes and the data collected by the probes.

Table 1-1. Types of data collected for the Operable Unit 7-13/14 Probing Project.

Data Source	Data Type	Data Examples
Type A probe: downhole nuclear logging tools	Digital files— counts/second and energy levels	Single-event digitally collected logs from the following instruments: <ul style="list-style-type: none"> • Passive-gamma detector for identifying gamma-emitting sources • Neutron activation instrument to detect prompt gamma from Cl-35, an indicator for halogenated hydrocarbons • Neutron-neutron detector to evaluate soil moisture • Passive-neutron detector for detecting transuranic radionuclides • Shielded, directional gamma detector to identify azimuthal location of gamma- emitting sources.
Type B probe: tensiometers	Matric potential in a soil matrix	Pressure data collected initially on dataloggers. Ambient pressure (centimeter of water). Gross matric potential (centimeter of water).
Type B probe: soil moisture probes	Relative moisture content in the surrounding material	Moisture content (percent by volume), resistivity (ohm-meters), dielectric constant (MHz), and temperature data (°C) collected initially on dataloggers.
Type B probe: lysimeters	Analytical results	Analytical laboratory results for contaminants of concern contained in water samples.
Type B probe: visual probes	Video recordings, optical televiewer, and digital images	Video recording and potentially digital stills taken as downhole optical logs.
Type B probe: vapor ports	Analytical results	Volatile organic compound concentrations (from field instruments and laboratory gas chromatography/mass spectrometry analyses) from vapor ports located within the pits. Radioactive gas (C-14 and tritium) laboratory samples from vapor ports located next to soil vaults.

Type A probes are steel pipes fitted with a drive point, installed in the waste zones. The probes allow nuclear logging instruments to be lowered to the subsurface (inside the uncontaminated pipe) so that nuclear sources and nuclear detection devices can record nuclear spectral data from the waste zone. Type A probe data, generated by the nuclear logging instruments, have been used to select locations for many of the Type B probes.

Type B probes also are drilled into the landfill to collect physical samples (gas and liquid) or to collect in situ geotechnical data. Soil vapor probes are installed to collect soil gas samples from specific locations for laboratory analysis. Lysimeters are designed to extract soil moisture and provide a liquid

sample for analysis. Tensiometers measure matric potential by sensing how tightly water is held in the soil. Soil moisture probes measure the temperature and electrical characteristics of the soil to determine soil moisture content. Visual probes are constructed from steel rods, stabilizers, tool joints, and Lexan tubes. The insides of the visual probes are open so visual images can be recorded from the inside of the probe looking out through the Lexan tubes, which form the outside wall of the probes. Table 1-1 provides additional detail on the characteristics of the data collected by the Type A and Type B probes.

The general approach to the OU 7-13/14 Probing Project, including placement of original Type A probes, was outlined in the *Probehole Plan* (INEEL 2000). The general approach established focus areas for investigation based on the shipping and inventory records. Type A probes were installed in transects to identify certain specific waste types and waste shipments. The Type A data were analyzed and used to establish the locations for individual and clusters of Type B probes.

Installation and monitoring of the Type B probes are described in *Field Sampling Plan* (Salomon 2003). Type B probes include tensiometers, suction lysimeters, vapor ports, visual probes, and soil moisture probes. Three hundred and thirty-seven Type A and Type B probe and instrument packages were installed in the SDA as part of the probing project between December 1999 and November 2001. Specific numbers of the types of probes include:

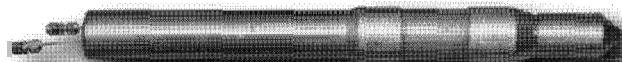
- 66 tensiometers.
- 78 soil moisture probe instruments (51 physical probes, some being multi-instrumented).
- 30 vapor ports.
- 18 lysimeters.
- 10 visual probes.
- 135 Type A probes, which excludes 10 probes not logged because of shallow completions (less than 6 ft 3 in.). Five of the shallow probes were replaced with deeper probes, which were logged.

An additional 37 Type A probes were installed in the SDA during FY 2003, as shown in Table 1-2, and the nuclear logging data from these probes are discussed in Section 7. The data from these Type A probes will be used to select locations for additional Type A probes and to select locations for new and replacement lysimeters and soil moisture, resistivity, and temperature (SMR) probes in FY 2004. Locations of the new Type A probes listed as tasks in Table 1-2 are shown in Figure A-1 with each task referencing an area of the same number.

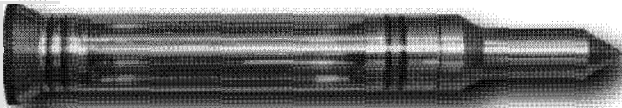
The types of probes used in the OU 7-13/14 Probing Project are illustrated in Figure 1-1. Figure 1-2 provides a view of a typical probe suite. Appendix A contains maps representing the surveyed locations of Type A and Type B probes installed in the SDA. Data generated from these probes are being used to support assessment of infiltration through the waste, release rate and solubility of uranium, release rate of C-14, and mass of the volatile organic compound (VOC) source remaining. The results will support the OU 7-13/14 Probing Project and ultimately verify and validate the Comprehensive Environmental Response, Compensation, and Liability Act-based OU 7-13/14 comprehensive remedial investigation/feasibility study. Operable Unit 7-13/14 is the comprehensive OU for Waste Area Group 7.

Table 1-2. Fiscal Year 2003 Phase I new Type A probes.

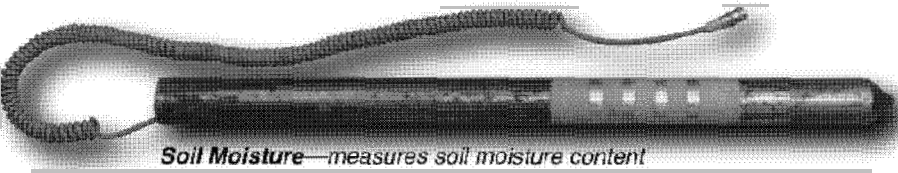
Task	Location	Target	Objective	Type A Probes (yes/no)	Phase I Type A Probes Installed	
1a	West end of Trench 3 in proximity of Well W 23. Analytical data indicate uranium in vadose zone.	Uranium mobility and uranium disposal in Subsurface Disposal Area	Characterize location in Subsurface Disposal Area with uranium disposal	Yes. Type A probes required to confirm location and allow determining source.	4 probes installed, no enriched uranium, possible still bottoms, high Cs-137	4
1b	Trench 47, eight spent nuclear fuel packages disposed of in 75-ft section of trench.	Waste with characteristics of spent nuclear fuel disposed of in Subsurface Disposal Area	Characterize spent nuclear fuel disposal in Subsurface Disposal Area	Yes.	4 probes installed; cobalt, cesium, and europium observed; azimuthal recommended	4
1c	Deep lysimeter clusters between Pit 15 and Trench 57.	Irradiated fuel material	East end of Subsurface Disposal Area monitoring	No. Two lysimeters will be collocated with deep lysimeters.	No Type A probes required; Type B lysimeters will be placed in locations selected for deep lysimeter monitoring	—
1d	Unrecorded shipment between Pits 1 and 2, and Pit 3.	Unrecorded shipment in Subsurface Disposal Area	Characterize unrecorded shipment location	Yes.	9 probes installed, possible azimuthal logging and additional probes	9
2	West end Trench 24, close to Trench 22. Two shipments, 3,000 gal, 2 yd, water and diatomaceous earth. 1.6 Ci Co-60.	Liquid disposals in Trench 24	High-activity liquid waste disposals could change release assumptions	Yes.	4 probes installed, HAL-2 saturated gamma tool, high neutron also, azimuthal recommended	4
3	Unknown source of the C-14, Tc-99, and tritium. Several uranium shipments in Pit 5.	Define source of contaminant of concern detections near and beneath Pit 5	Uranium trends and plutonium beneath Pit 5	Yes. Type A probes to confirm location and allow determining source amount required.	8 probes installed, the presence of large quantities of plutonium, americium, and neptunium waste and uranium waste is confirmed, azimuthal logging recommended	8
4	See replacement probe summary for detail of probe placements.	Replacement probes	Some existing Type B probes are not working, or further Type A investigation targets the source areas	Yes. Type A probes are necessary to better delineate source of moisture at Cluster 741-08.	2 probes installed, plutonium, americium, and neptunium not located, enriched uranium present, azimuthal logging recommended and possible Type A probe cluster	2
5	Upper-central part of Pit 6, area with high plutonium density.	High plutonium density in Pit 6	Characterize Rocky Flats Plant drum shipments with high plutonium densities in Pit 6	Yes. Characterize with nuclear logging tools.	3 probes installed, high levels americium, azimuthal recommended	3
6	Upper-central part of Pit 10, area with high plutonium density.	High plutonium density in Pit 10	Characterize Rocky Flats Plant drum shipments with high plutonium densities in Pit 10	Yes. Characterize with nuclear logging tools.	3 probes installed, no significant detections	3
Total					37	37



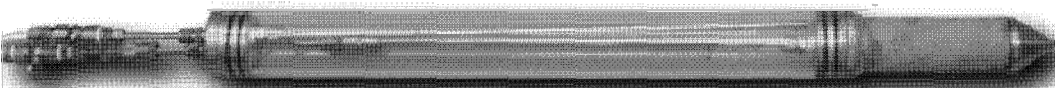
Vapor—detects and collects gas and vapor samples



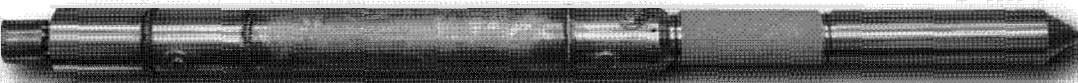
Visual—allows visual inspection of subsurface conditions (tip section only)



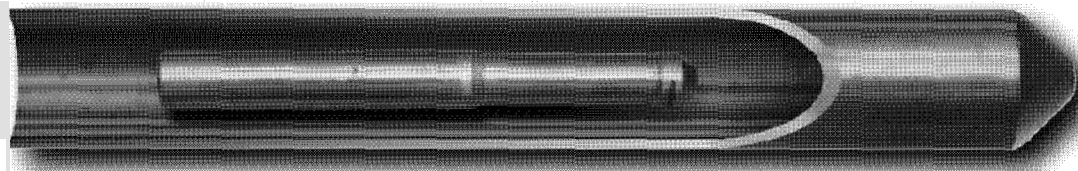
Soil Moisture—measures soil moisture content



Lysimeter—collects water/liquid samples (unit shown is a development model which has clear plastic in place of stainless steel wall components to show probe internals)



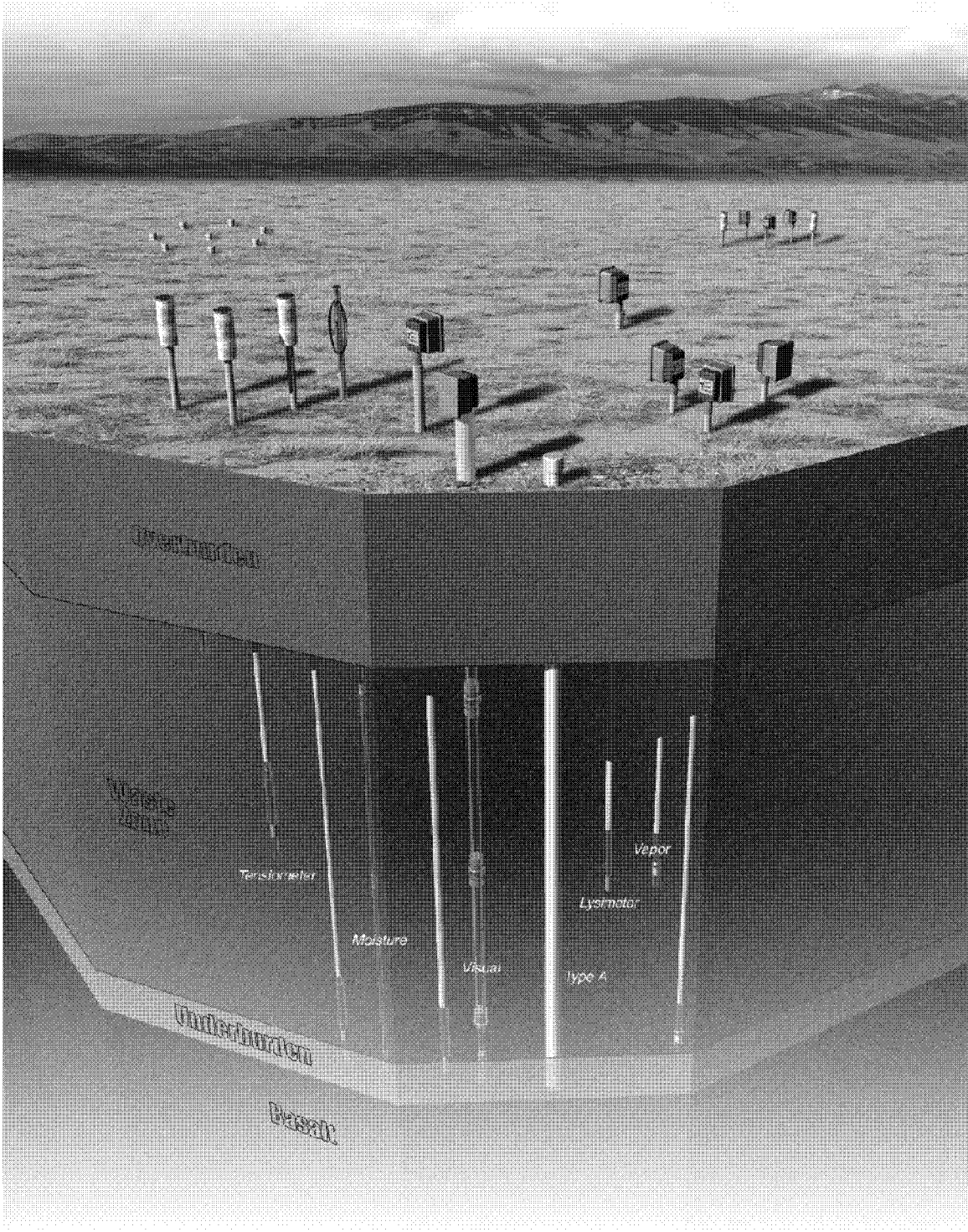
Tensiometer—measures movement of water



Type A—accommodates interchangeable logging tools that detect contamination

03-GA50310-03

Figure 1-1. Probe types used in the Operable Unit 7-13/14 Probing Project.



03-GA50310-04

Figure 1-2. Typical probe suite installed in the Subsurface Disposal Area.

1.4 Document Organization

This document is organized by probe and the type of data collected by the probe. The Type B probes are presented first and are presented in the following order: soil vapor probe, lysimeter, tensiometer, soil moisture probe, visual probe, and Type A probe. The nuclear logging data from the Type A probes are presented last. Appendix A contains maps showing the focus areas and probes installed within the focus areas. Appendix B contains a table of probe attribute data (e.g., probe names, survey information, sample port depths, and various other support information compiled during installation). Appendixes C and D contain supporting data for SMR probes and tensiometers.

1.5 Meteorology

The lysimeters, tensiometers, and soil moisture probes all rely on the water in the soil to perform their function. While some instruments have had mechanical or electrical problems that have inhibited their ability to provide as much data as desired, the monitoring environment also has made in situ monitoring very difficult. The very dry soil conditions can contribute to difficulty in obtaining a lysimeter soil moisture sample, to additional maintenance required on tensiometers, and to difficulty in measuring resistance and conductivity with SMR probes. The INEEL Site has experienced three of the driest years on record in 2001, 2002, and 2003 with 4.87, 4.53, and 3.91 in. of precipitation, respectively, which have caused extremely dry waste-zone conditions.^a See Figure 1-3, which shows the annual precipitation since 1951. In 52 years of keeping records, the only year that has been as dry is 1966 with 4.5 in. of precipitation. Lysimeters also have been unable to produce reliable samples and data. Only Probe 741-08-L1 has produced consistent samples for a short period but has failed to produce any water in the last sampling rounds.

The amount of winter precipitation is another indicator of the amount of soil moisture available to increase subsurface moisture content. Snow typically accumulates in the winter and melts in spring, infiltrating into the soil when there is little evaporation usually providing one of the best opportunities for encountering soil moisture during the year. Precipitation that occurs in the summer has a much greater potential to be evaporated back into the atmosphere before infiltrating into the soil beyond the evaporation range. The winter precipitation for the last 4 years, 1999–2000, 2000–2001, 2001–2002, and 2002–2003 has been 2.57, 1.8, 2.63, and 1.5 in., respectively, well below the 51-year average of 3.23 in. See Figure 1-4, which shows the winter precipitation since 1951. Extremely dry conditions are a contributing factor in the performance of the lysimeters, tensiometers, and soil moisture probes.

a. Data for the Central Facilities Area weather station obtained from Neil Hukari at the National Oceanic and Atmospheric Administration.

Annual Precipitation at INEEL (CFA)

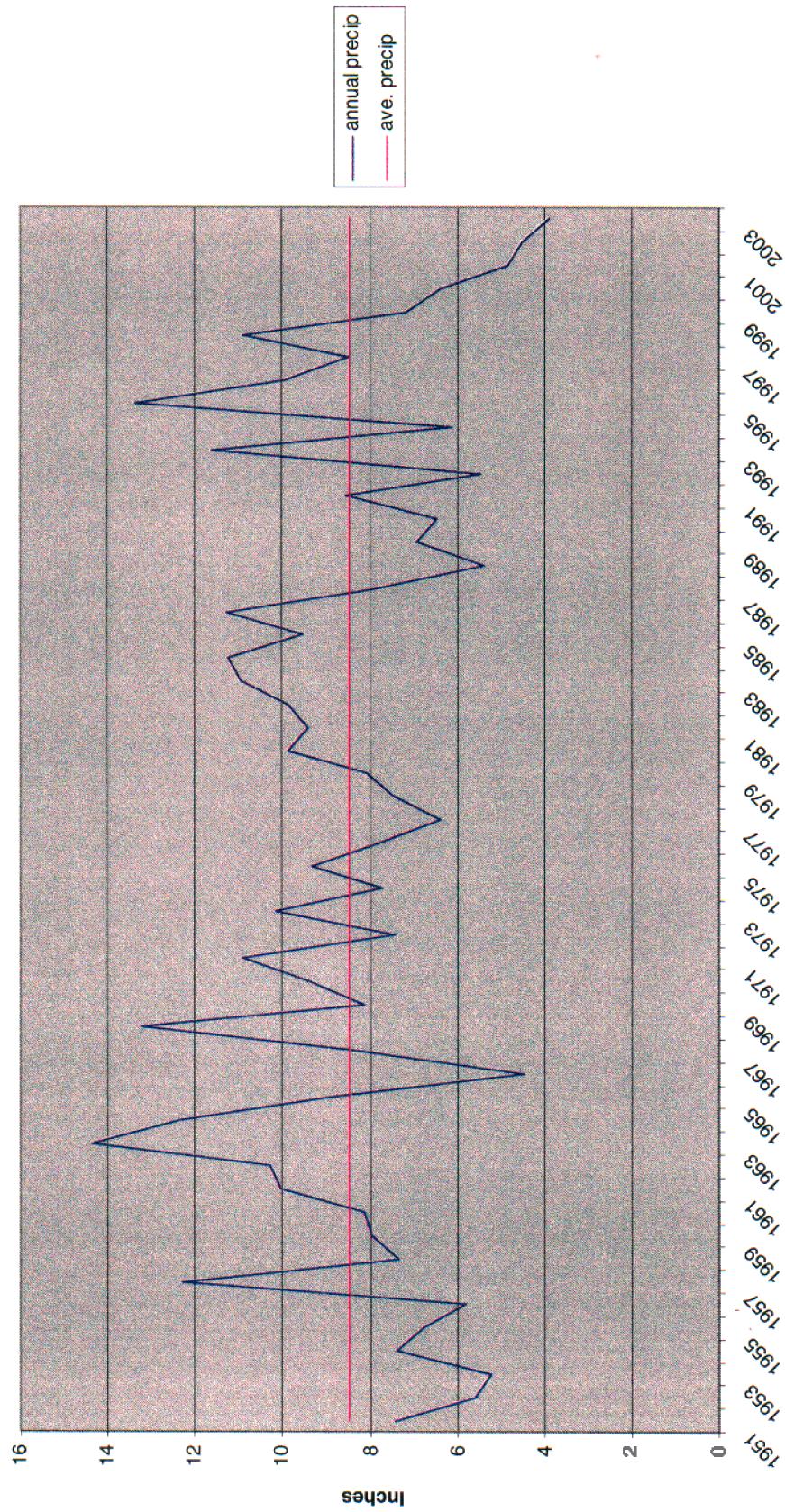


Figure 1-3. Annual precipitation at the Idaho National Engineering and Environmental Laboratory (Central Facilities Area).

Winter Precipitation at INEEL (CFA)

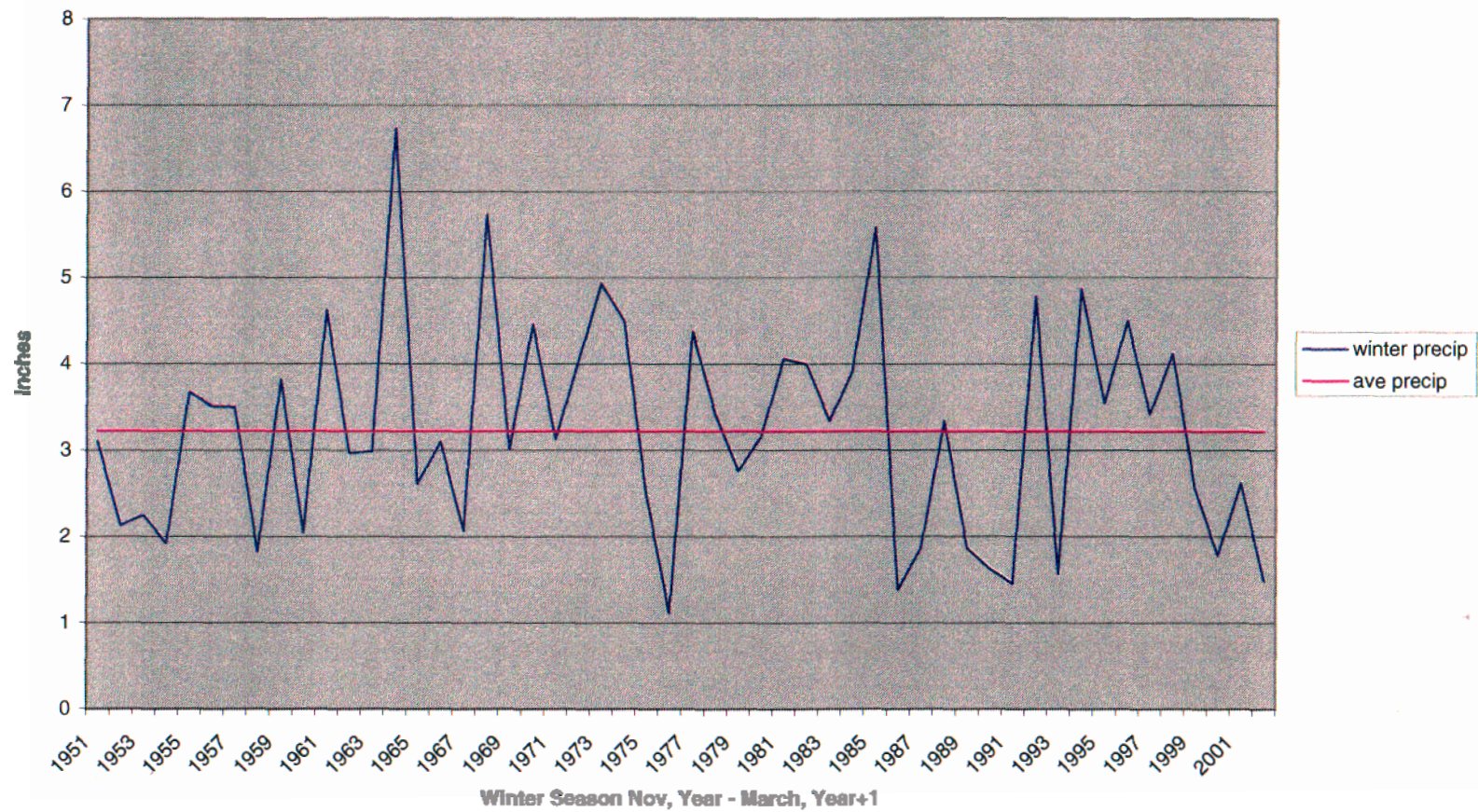


Figure 1-4. Winter precipitation at the Idaho National Engineering and Environmental Laboratory (Central Facilities Area).

